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(54) **Assembled camshaft**

(57) An assembled camshaft comprises a one-piece or assembled tubular shaft and elements in the form of cams or bearing shells held principally by friction under constant pre-tension as a result of radial hydraulic expansion of the tubular shaft. The tubular shaft is made of a material with a yield strength of approximately 300 N/mm² and a structure that is stable up to a temperature of at least 600°C. The elements may be made of a hardenable casting material with a yield strength greater than or equal to 500 N/mm² and a minimum elongation of 1 to 2%. After joining the tubular shaft and the elements, the entire camshaft is thermochemically treated at a temperature of approximately 600°C, e.g. bath-nitrided, soft nitrided, bonderized or treated with boron, giving improved wear resistance of the cam surface. The cams may be subjected to an induction or remelting hardening process before location on the tubular shaft.

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ASSEMBLED CAMSHAFT

This invention relates to a process for producing an assembled camshaft comprising a one-piece or assembled tubular shaft and elements in the form of cams or bearing shells held on the shaft principally by friction locking as a result of radial hydraulic expansion of the tubular shaft. The invention also relates to camshafts made by this process.

Assembled camshafts of the type described above have been undergoing development for a considerable time, but the full range of demands made of volume-produced products has not yet been satisfied. The elastic properties of steel cams can be exploited to obtain a perfectly torsion-proof connection between cam and shaft, but wear resistance is not always satisfactory at high loads.

In the case of cast cams, strength problems arise in conjunction with the high expansion pressures used to obtain a torsion-proof connection. Here again, enhanced wear resistance would also be desirable.

The present invention has the object of providing a process for producing assembled camshafts with improved wear resistance at the cam surface compared with currently available products.

The invention provides a process for producing an assembled camshaft comprising a one-piece or assembled tubular shaft and elements in the form of cams or bearing shells held principally by friction locking as a result

of radial hydraulic expansion of the tubular shaft, wherein the tubular shaft material has a yield strength of approximately 300 N/mm^2 and a structure that is stable up to a temperature of 600°C, the elements are initially fixed on the tubular shaft by hydraulic expansion, and the entire camshaft is thermochemically treated at a temperature of approximately 600°C.

In a process according to the last preceding paragraph, the tubular shaft material is chosen with a yield strength of approximately or substantially 300 N/mm^2 or below and a structure that is stable up to a temperature of at least 600°C or above, e.g. a heat-resistant steel such as 10 Cr Mo 9 10 steel, and the elements are initially fixed on the tubular shaft by hydraulic expansion and the entire camshaft is subjected to thermochemical treatment at a temperature of approximately or substantially 600°C without loss of component elasticity at the contact surfaces. In accordance with the invention, the tubular shaft material, e.g. a heat-resistant steel such as 10 Cr Mo 9 10 steel, is selected specifically to permit surface treatment such as not previously used on constructed shafts of this type because the required process temperatures tended to reduce the pre-tension of the fixed elements and thus release the torsion-proof connection. On the other hand, thermochemical treatment (bath nitriding, soft nitriding, bonderizing and treating with boron in particular) of the elements before fixing on the camshaft is not desirable because bright seat surfaces are essential to provide a better join and prevent significant loss of strength in the friction-locking connection caused by unsuitable surfaces.

In an especially favourable further development of the process the adjacently arranged individual elements are subjected to a hardening process before location on the tubular shaft, in particular by subjecting them to an induction or remelting hardening process.

The invention also provides a camshaft made according to a process in accordance with the invention, wherein the drive elements are made from a hardenable casting material with a yield strength greater than or equal to 500 N/mm^2 and a minimum elongation of 1 to 2%. This gives especially favourable wear properties. Such elements will preferably be induction-hardened black heart castings with a martensitic structure or malleable iron castings hardened by remelting with a ledeburitic structure.

CLAIMS

1. A process for producing an assembled camshaft comprising a one-piece or assembled tubular shaft and elements in the form of cams or bearing shells held principally by friction locking as a result of radial hydraulic expansion of the tubular shaft, wherein the tubular shaft material has a yield strength of approximately 300 N/mm^2 and a structure that is stable up to a temperature of 600°C, the elements are initially fixed on the tubular shaft by hydraulic expansion, and the entire camshaft is thermochemically treated at a temperature of approximately 600°C.

2. A process according to Claim 1, wherein the adjacently arranged individual elements are subjected to a hardening process before location on the tubular shaft.

3. A process according to Claim 2, wherein the elements are hardened in a remelting hardening process.

4. A process according to Claim 2, wherein the elements are subjected to an induction hardening process.

5. A process according to any one of Claims 1 to 4, wherein the entire camshaft is bath-nitrided.

6. A process according to any one of Claims 1 to 4, wherein the camshaft is soft-nitrided.

7. A process according to any one of Claims 1 to 4, wherein the entire camshaft is bonderized.

8. A process according to any one of Claims 1 to 4, wherein the entire camshaft is treated with boron.

9. A camshaft made according to a process according to any one of the preceding claims, wherein the drive elements are made from a hardenable casting material with a yield strength greater than or equal to 500 N/mm^2 and a minimum elongation of 1 to 2%.

10. A camshaft according to Claim 9, wherein the drive elements comprise induction-hardened black heart castings with a martensitic structure.

11. A camshaft according to Claim 9, wherein the drive elements comprise malleable iron castings hardened by remelting with a ledeburitic structure.

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ABSTRACT:

CHG DATE=19940730 STATUS=O> An assembled camshaft comprises a one-piece or assembled tubular shaft and elements in the form of cams or bearing shells held principally by friction under constant pre-tension as a result of radial hydraulic expansion of the tubular shaft. The tubular shaft is made of a material with a yield strength of approximately 300 N/mm<2> and a structure that is stable up to a temperature of at least 600 DEG C. The elements may be made of a hardenable casting material with a yield strength greater than or equal to 500 N/mm<2> and a minimum elongation of 1 to 2%. After joining the tubular shaft and the elements, the entire camshaft is thermochemically treated at a temperature of approximately 600 DEG C, e.g. bath-nitrided, soft nitrided, bonderized or treated with boron, giving improved wear resistance of the cam surface. The cams may be subjected to an induction or remelting hardening process before location on the tubular shaft.